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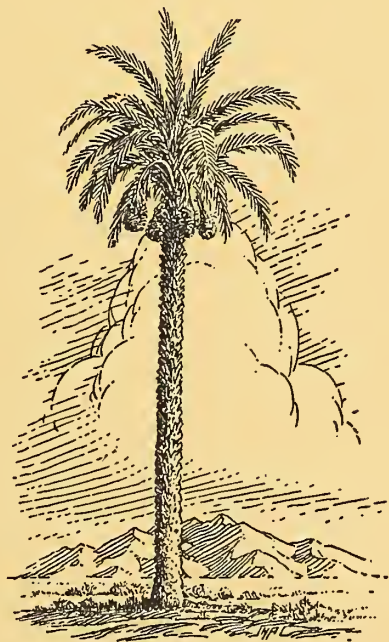
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REPORT OF

Thirtieth Annual

DATE GROWERS' INSTITUTE

APRIL 25, 1953



HELD IN

COACHELLA VALLEY

CALIFORNIA

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Thirtieth Annual DATE GROWERS' INSTITUTE

HELD IN
**COACHELLA VALLEY
CALIFORNIA**

APRIL 25, 1953

VOLUME 30

CHAIRMAN MORNING SESSION

F. W. Went

Professor of Plant Physiology
California Institute of Technology

CHAIRMAN AFTERNOON SESSION

T. J. Gridley

Date Grower

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The Date Growers' Institute is the official educational instrument of the date industry. Its goal is the dissemination of information on date growing, handling and marketing. This is its thirtieth year. Proceedings of each Institute have been published, and may be purchased in complete sets, or by separate copies. A full index will be mailed on request. Direct all inquiries to the Secretary.

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ROOT HAIR DEVELOPMENT ON DATE PALMS

By F. W. Went and Ellis Darley

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INTRODUCTION

There seems to be very little written on root development in the date palm. However, several observations have been made and these will be reviewed.

GENERAL

ROOT DEVELOPMENT

Being a monocotyledon, the date palm has a fibrous root system, made up of a large number of secondary roots, more or less uniform in thickness, arising from the base of the stem (4). Roots are found at some depth and distance from the tree. Simmons (6) describes an excavated root on a palm in Arizona that went down for seven feet and then extended laterally for a distance of 27 feet. Bliss (1) in California and Milne in the Punjab found that greatest concentration of roots was in the second, third, and fourth foot levels, with several extending to the sixth and seventh foot levels. The height of the water table appears to influence depth of rooting as will be pointed out later.

Bliss (1) describes and illustrates five ranks of roots: primary, secondary, tertiary, quaternary, and quintary. All but primaries arise from the pericycle of the next older root. Primary, in the sense he used it, is the first order of root arising from the base of the tree and not the true primary root arising from the germinating seed. Thus the primary root of Bliss and the secondary root of Milne are synonymous.

ROOT HAIRS

Opinions differ as to the presence of root hairs. Bliss (1) found none in his careful study of many roots in California and Kerner and Oliver (3, see p. 91) state that the date palm does not have root hairs. On the other hand Milne (4) reports that he has seen them on several occasions and in particular on palms growing on well drained soil with a water table at 80 feet and on roots at a depth of 7½ feet where at the time of examination the water level was at 9 feet.

To explain the lack of root hairs, Kerner and Oliver develop an interesting thesis that plants that lose great amounts of water must provide for greater absorption by extending the absorptive root cells into long tubes. Therefore plants with thin, delicate leaves that transpire readily have numerous root hairs. On the other hand, plants with leathery leaves in which a thick epidermis protects them from excessive transpiration, as in the date palm, have non-extended ab-

sorptive root cells (no root hairs) because they do not need them.

Simmons (6) notes that absorptive surface on feeder roots is much increased by root hairs, and that to obtain, "such a surface without root hairs would mean the development of a root many times as long as the present root." It is not clear from this whether he is considering date roots or believes date palms have root hairs. W. T. Swingle observed (see 6), "We cannot discern the root hairs because on date palms they are not as obvious as on other plants."

MOISTURE IN RELATION TO ROOT DEVELOPMENT

Roots are very tolerant to high soil moisture. Milne illustrates two palms that have stood in water for six years. They are in poor health but still living. Bliss reports a Canary Island palm having stood in water for twelve years. Bliss further reports his own experiments, where eleven-month-old seedlings were grown in each of two five gallon cans. One can was submerged in water to the soil level for three years and the other received the usual watering. Growth was depressed in the submerged plants. Only a few immersed roots remained alive at the bottom of the container. Most of the live roots were near the surface.

In Arizona, Simmons reports roots are very tolerant of free soil water and the extent of their development seems to be related to the position of the water table. Roots did not penetrate the water table very far but those that did were alive and healthy. When the water table was lowered by drainage, the roots followed it down to a depth of 10 to 14 feet.

In view of the controversy in the literature, whether dates form root hairs, we studied the problem in several different ways.

In the first place, date seedlings were grown in nutrient solution. Under those conditions, no root hairs were observed. This is not surprising since most plants do not form root hairs when their roots are submerged in a liquid. In nutrient solutions the calcium content of the solution is critical, and within a certain range of concentrations root hairs may be formed (2).

In hydroponics it is generally observed that on the roots developing above the level of the nutrient solution root hairs are formed. But where such roots dip into the solution, root hair formation stops suddenly. One would therefore expect ideal conditions for root hair formation when

roots were grown in air saturated with water vapor.

For this purpose a method was developed, first used by Raines (5), and subsequently applied to pineapples, orchids and apple seedlings. By this method, plants are grown with their roots in a fine fog of nutrient solution. This fog condenses on the roots which are thus supplied with liquid plus the necessary nutrients. Under these conditions very large root systems develop with long, strongly branched roots, and all younger roots are covered with root hairs. On tomatoes, carrots, strawberries, corn and many other plants, the roots thus produced look much more normal than those produced in nutrient solution, which usually are poorly branched and do not have root hairs.

For about ten years, attempts were made at Caltech to have such a fog box for root growth work reliably. But it was not until Mr. Keyes introduced a number of special features that it became a useful tool in physiological research. These features are to be described in short.

A wooden box with a transparent plastic front side, 5 ft. wide, 4 ft. high and 2 ft. deep is covered inside with a watertight, black asphaltic varnish coating. The top consists of 10 by 10 in. panels which can be removed, and in the center of which the base of the stem of a plant is wedged, with the roots protruding into the box. The plastic window in front is normally covered with a light-tight lid, to keep the roots in darkness.

The nutrient fog is produced by two regular atomizer spray heads in each fog box. This dual injection is essential because the sprays clog up rather frequently, and even a few hours interruption of the spray usually means complete wilting of the plants, when the root system is most severely injured. The sprays are operated with compressed air at 60 pounds per square inch, and the nutrient solution is fed in from tanks in which the proper mixture is prepared. When too much fog is produced, an excess of nutrient condenses on the roots and drips off. This reduces root hair formation and causes the formation of a root system resembling that formed in water culture.

The amount of fog can be controlled in several different ways. The droplet size is dependent upon the air pressure and the rate of feed of nutrient solution, which can be varied with a needle valve. Another way is



to make the spray guns work intermittently. This method has the advantage that it is easy to change as the water requirements of the plant change. Two solenoid-actuated valves are put in the compressed air and nutrient solution supply lines. A time-clock energizes the solenoid valves. In our present operation the spray is produced 15 seconds out of every minute during daytime (8 a.m. to 8 p.m.) and 2 seconds per minute during night.

Not only the quantity of fog spray is critical, but even more so, the concentration of the nutrient solution. Since we try to supply just enough fog, so that no dripping off the roots occurs, the concentration of the nutrient should be adjusted so that the rate of water intake parallels the rate of nutrient uptake. When too concentrated, the nutrients form an accumulation of nutrient salt on the root surface, and the roots show signs of poisoning and the tips die. But too dilute a solution produces immediate signs of nutrient deficiency. Thus it was found that any nutrient concentration above 0.25 x Hoagland (0.40, 0.50, 1.00) causes root injury, whereas 0.15 x Hoagland causes deficiencies. When the iron in the nutrient solution is supplied as a chelate, no iron deficiencies show up in the nutrient fog experiments, whereas as iron tartrate or iron citrate it was insufficient.

It also is important to keep the roots in darkness. Tomatoes grow very slowly when their roots are exposed to normal day light. This does

not seem to affect the roots as much as it affects the top growth. Therefore the roots in the fog box are kept as dark as possible.

Date seeds of the Deglet Noor were laid out to germinate in vermiculite. When the shoots started to show above ground, they were removed from the vermiculite and the seedlings were inserted with only their roots in the fog box. In the beginning the nutrient solution was too concentrated and the root development of these date seedlings was very poor. All new root tips turned brown and died. When the nutrient concentration of the fog was reduced to one-fourth strength Hoagland, growth of the seedlings improved, and a very fine root system developed. Big, white adventitious roots grew straight down. They developed primary and secondary rootlets of smaller and smaller diameter until the root system, shown in the accompanying picture, had developed. The cells of the calyptra stripped off regularly and formed irregular excrescences on the root surfaces. Otherwise the root surface was perfectly smooth without any trace of root hairs. This was observed at any time on any of the date roots and rootlets. On other plants which were grown simultaneously in the same fog box, root hairs were produced in abundance. Therefore we can conclude that under conditions which are optimal for root-hair formation in other plants like tomatoes and corn, no root hairs are found on the roots of the date palm.

It is always difficult to say with certainty that no root hairs are found

on the roots grown in soil since it is possible that such root hairs have been removed by removing the soil. In the case of the fog box the absence of visible root hairs is incontrovertible evidence that no root hairs were present in the first place. The conclusion seems well founded that date palms do not normally form root hairs.

DISCUSSION

Root hairs increase the root surface of plants in a remarkable way. They enable the plant to reach the least available amount of water and nutrients in the soil which otherwise would not be available to the plant since below field capacity water moves very slowly in the soil. In very wet soil, root hairs would be superfluous since a sufficient amount of water could be reached by the roots and rootlets without further increasing their surface. We find that on roots grown in liquid or in very moist soil no root hairs develop.

Apparently the date does not have the ability to form root hairs. From this we might conclude that the date palm is adapted to permanently moist soils. Their natural habitat is on oases where the ground water comes very close to the surface. Under these conditions no root hairs are necessary to the uptake of water. These observations show to what extent date palms need irrigation. There always should be liquid water around the major portion of the root system which means frequent irrigation or a high water table.

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A STUDY OF SPOILAGE AND THE MICROORGANISM POPULATION OF SOFT DATES

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It has been the goal of the Arizona date industry to market a high quality, high moisture, soft, fresh date which will withstand reasonable transport and display periods without microbiological or physical deterioration. Such soft dates have chemical and physical characteristics which make them particularly favorable media for the growth of spoilage organisms.

In spite of the fact that attempts are made to handle dates in a sanitary manner in the packing house, losses from spoilage during processing, storage and shipment are an important factor in increasing costs.

In general, three classes of microorganisms contribute to date fruit spoilage: (1) Yeasts, which comprise the largest and most important group and are responsible for the fermentation of sugars into alcohol and carbon dioxide; (2) molds, which may ferment sugars, but which are more objectionable because of their wooly type growth; (3) the acid bacteria, which can cause souring by converting sugar into lactic acid or by converting the alcohol of yeast fermentation into acetic acid.

The experiments reported herein evaluate the changes in numbers of such organisms as they are affected by the various conditions encountered in the field and packing house. It may not always be true that the amount or rate of spoilage is related to the numbers of microorganisms present on the fruit. However, counts of microorganisms are commonly made on the products of other food industries as an evaluation of handling techniques. These experiments will clearly indicate points of contamination and means of improving packing house management.

METHODS

Fruit was selected as indicated in each experiment. Every colony count reported is an average of counts from four to eight separate random samples of three fruits each. The three-fruit samples were placed in wide-mouth jars of sterile distilled water and shaken vigorously 100 times.

After appropriate dilution, standard plate counts of the total number of colonies of yeasts, molds and bacteria were made on tryptone glucose brom-cresol purple agar. No attempts were made to identify species involved.

RESULTS AND DISCUSSION

MICROORGANISM POPULATION CHANGES IN THE FIELD

Counts of microorganisms on fruit sampled directly from the field show that the relative numbers of yeasts, molds and bacteria present are greatly influenced by the time of the season (Table 1).

The population of yeast cells on Iteema fruit from garden A decreased from 2,800,000 per fruit on September 21 to 5,900 per fruit on November 6. The mean daily temperature during this period dropped from 82° F. in September to 65° F. in November. Molds tended to increase and bacteria to decrease with lowering temperatures, but the total numbers of each were much less than of yeasts. Similar changes were noted with Hayany fruit from garden B.

The data suggest that different varieties may tend to harbor varying numbers and proportions of microorganisms. While the numbers of molds and bacteria found on Hayany fruit from garden A are comparable to Iteemas from garden B, considerable differences in number of yeasts occur, especially in the early part of the season.

The different types and relative numbers of organisms on Iteema and Maktoom fruit are compared in Figure 1. Slices of fruit chosen at random from palms in the same garden were placed in sterile petri dishes and melted potato dextrose agar was poured over the surface. After 48 hours incubation, vast numbers of



Figure 1. Comparison of types and numbers of microorganisms occurring naturally on Maktoom and Iteema dates. (Potato dextrose agar, pH 5.5, 48 hrs. room temp.)

yeasts appeared on the Iteema cultures, whereas relatively few organisms appeared on the Maktoom cultures, and most of them were mold types.

These data are correlated in a general way with observed spoilage. Considerable spoilage occurred early in this season and almost none late in the season. More spoilage occurred with the Iteema than with the Maktoom.

Perhaps the natural condition of the surface of the fruit in the field has much to do with its susceptibility to spoilage. The Iteema fruit studied was characterized by a sticky and syrupy condition of the skin, whereas the Hayany and Maktoom fruit sur-

Table 1 Seasonal Changes in Microorganism Population of Iteema and Hayany Dates

1950	No. organisms per fruit					
	Iteema			Hayany		
	9/21	10/10	11/6	9/27	10/23	
Yeasts	2,800,000	40,000	5,000	76,000	11,100	
Molds	7,000	3,900	25,000	12,000	5,300	
Bacteria	10,000	29,000	3,600	14,000	28,000	

Table 2. Effect of Fumigation and Washing on the Microorganism Population of Iteema Dates

	No. organisms per fruit (9/21/50)		
	Yeasts	Molds	Bacteria
Field run	2,800,000	7,000	10,000
After fumigation ¹	5,300	6,400	5,000
After washing ²	1,400,000	7,100	5,800
½ matured	5,900,000	3,900	250

1. CARBOXIDE, 8 lbs. per 1000 cu. ft. for 16 hours.

2. Hand operated shaker-table lined with turkish towels rinsed in water only.

faces were very dry offering little opportunity for the adherence and growth of microorganisms.

MICROORGANISM POPULATION CHANGES DURING PROCESSING

Fumigation. A number of fumigants are presently used to kill insects, larvae and eggs. Mrak (2) reported that yeasts obtained from dates can be killed by methyl bromide or ethylene oxide but the times and concentrations are much greater than those used for insect control. To evaluate this factor under commercial conditions, colony counts were made on Iteema fruit fumigated with the regular commercial dosage of CARBOXIDE (8 lbs. per 1000 cu. ft. for 16 hours). A large reduction in the number of yeasts and a somewhat smaller reduction in number of bacteria resulted, but molds seemed to be unaffected (Table 2).

Further tests showed that methyl bromide at a concentration of 1 lb. per 1000 cu. ft. was almost as effective. Laboratory tests with small lots of fruit showed that concentrations of 60-300 lbs. of ethylene oxide or methyl bromide per 1000 cu. ft. for 16 hours were required to attain complete sterility. At these concentrations, however, enough methyl bromide was absorbed by the fruit to inhibit the ripening processes and produce a strong taste and odor of bromine. High concentrations of ethylene oxide caused the epidermal layers of khalal fruit to rupture, in a manner similar to the reaction of the fruit to high atmospheric moisture conditions.

Washing and Maturation. In packing house A fumigated fruit was washed on a hand operated shaker-table lined with turkish toweling which was rinsed in plain water. Two lots of fruit were washed, one on each surface, before the towel was returned to the tub for re-rinsing.

The results of colony counts on fruit washed in this manner showed that the mold and bacterial population was practically unaffected by washing and the number of yeasts were increased to one-half the number present before fumigating. Under the high humidity and warm temperature conditions of the maturation rooms this number was further increased to over twice the original number before the fruit was finally

cured to a point where spoilage could not occur.

The results in Table 2 show that washing dates with toweling rinsed in tap water resulted in an increase in the number of microorganisms. Therefore, tests were conducted in packing house B to evaluate the effect of washing in water containing the following disinfectants: (1) 200 ppm sodium hypochlorite solution; (2) 200 ppm ROCCAL solution, a proprietary quaternary ammonium compound. These solutions markedly reduced the population of all microorganisms (Table 3). ROCCAL produced slightly better control than hypochlorite, especially of bacteria.

Pasteurization. Pasteurization of dates has been the subject of considerable discussion and a large amount of work has been done. Results have not been entirely conclusive (1), (4), (6). Actually, the amount of dry heat required to kill the spores of molds and certain bacteria is so great that dates are caramelized and rendered worthless when so treated. Table 4 demonstrates typical colony counts obtained from Hayany fruit before and after treatment at 165° F. (fruit surface temperature) for 30 minutes (packing house B). While the yeast population is reduced in both cases, the mold and bacterial populations were affected little or not at all.

Moisture Content and Fruit Color. During various experimental tests in

previous years (1) rather wide variations in the extent of fruit spoilage occurred between fruits with similar moisture contents. It appeared that some factor other than moisture was involved. In any lot of freshly picked fruit considerable variation in color is present.

To determine if fruit color is involved in spoilage a single lot of 100 fresh Khadrawy fruit of widely varying moisture contents (24%-48%) was graded into two groups for color—light and dark. Individual fruits were inoculated with a thin mixture of fermenting date pulp (to insure spoilage) by means of a needle. Each fruit was sealed inside a small glass jar to avoid moisture changes and stored at 75°-80° F.

Each was examined every 2-3 days for evidence of fermentation. When the odor of alcohol was unmistakable the fruit was withdrawn and its moisture content determined with a refractometer.

The data with mathematically fitted curves superimposed show clearly that the onset of fermentation is directly related to both moisture content and color of the fruit (Figure 2). The moisture content directly influenced the rate of growth of yeasts. All fruit containing over 34 per cent moisture fermented within 30 days, whereas fruit containing 28 per cent or less required more than 70 days to ferment.

Light colored fruit kept 4-18 days longer, depending on moisture content, than dark colored fruits. Evidence points to the fact that darkening is primarily an oxidative reaction involving the tannins (3). Tannins and tannin-like substances are thought to have a limited protective action against fungal attack (7). Possibly natural darkening of the fruit represents a loss of its protective mechanism, leading to more rapid spoilage.

Table 3. Effect of Washing on the Microorganism Population of Hayany Dates

	No. organisms per fruit		
	Yeasts	Molds	Bacteria
Field run	76,000	12,000	14,000
After washing, A	15,200	8,900	7,500
After washing, B	8,600	6,600	390

A Shaker-table, toweling rinsed in 200 ppm hypochlorite.

B Shaker-table, toweling rinsed in 200 ppm ROCCAL (quaternary ammonium compound).

Table 4. Effect of Pasteurization on the Microorganism Population of Hayany Dates

Test No.	No. organisms per fruit		
	Yeasts	Molds	Bacteria
1—Before past.	78,000	7,900	20,000
After past.*	5,600	4,700	20,000
2—Before past.	49,700	5,800	69,100
After past.*	8,500	4,300	19,100

*Heated at 165° F. (fruit surface temp.) for 30 min.

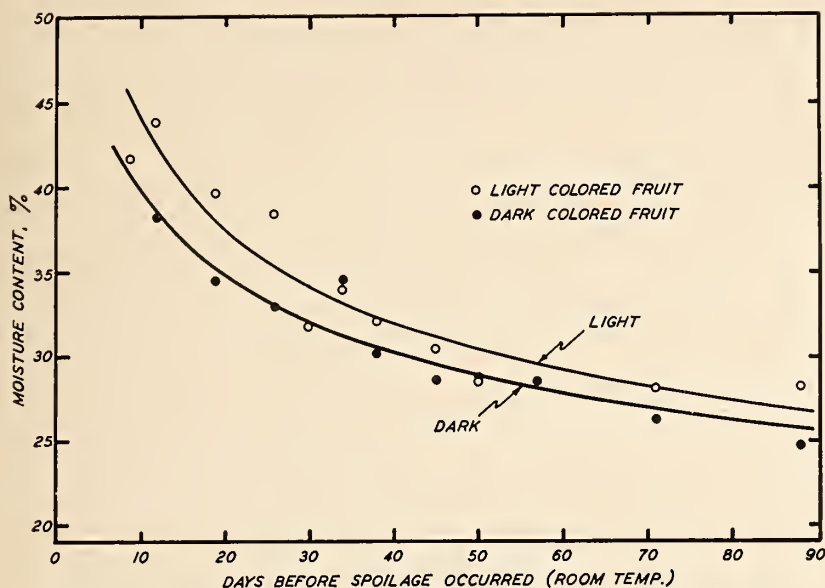


Figure 2. Relationship of moisture content and fruit color to spoilage (fermentation) of Khadrawy dates.

QUALITY CHANGES DURING COLD STORAGE

Occasionally, dates ripen so rapidly that the facilities for washing, fumigation and curing are inadequate in certain packing houses. Under these conditions, fruit has been placed in cold storage and cured later in the season.

To learn the effects of such cold storage practices upon microorganism populations, Khadrawy fruit was picked and placed directly in 32° F. storage without fumigation or washing. The moisture content of this fruit ranged from 35 per cent to 40 per cent. Samples for microorganism colony counts were taken of the fresh fruit and at intervals during the 61 day storage test. Data is presented in terms of the percentage of the initial number of organisms which

survive at each successive sampling date (Figure 3). A high death rate of all organisms began within 20 days after storage began and at the end of 40 days only 1 per cent or less of the original population survived.

Parallel studies at 0° F. showed that the rate of killing did not differ significantly from that at 32° F.

Sugar Spotting. Sugar spotting of date fruit during cold storage generally results in lowering the grade, although it does not harm the fruit for eating purposes. The condition has been studied previously and the effect of temperature and moisture content on its formation is known in a general way (1), (5). The results of the following test are offered in support of the earlier conclusions.

A single lot of 100 fresh Maktoom fruits with moisture contents ranging from 15 per cent to 39 per cent were divided equally and placed individually in small glass jars and sealed to avoid moisture changes during storage. Half were placed in a kitchen refrigerator averaging 32° F. and half were placed in a commercial food locker at 0° F. After fourteen months of storage an actual count of the individual sugar crystals was made on each fruit. These counts were correlated with storage temperature and with moisture contents determined with a refractometer as before (Figure 4).

Maximum crystal formation occurred at 27 per cent to 30 per cent moisture which is the most desirable range for marketing and shipping Arizona fruit. No sugar spotting occurred at moisture contents above 36 per cent, where microbiological spoilage occurs most rapidly. Storage at 0° F. reduced sugar spotting by an average of 51 per cent.

SUMMARY AND RECOMMENDATIONS

Date spoilage has been evaluated by studies of the population of microorganisms present on the fruit. Assuming that the magnitude of the population is an index of spoilage, the following packing house management recommendations can be made:

1. Larger numbers of yeasts and bacteria are present on the ripening fruit early in the season than late in the season. This should be recognized and greater care taken to reduce spoilage early in the season.
2. Dates may be highly contaminated during washing. Wash and grade the fruit prior to fumigation using a disinfectant in the towel rinse water.
3. Fumigation with standard quantities of either methyl bromide or CARBOXIDE kills a large percentage of the microorganisms inhabiting dates. The fruit should be cured immediately after fumigation in a clean room without further handling.
4. Pasteurization significantly reduces the yeast population, but does not affect molds or bacteria.
5. The microorganism population of dates is reduced during cold storage at 32° F. or lower. Possibly less spoilage will result if very moist dates are placed in dry storage at 26°-32° F. 30 days prior to processing.
6. Dates fermented at moisture contents above 25 per cent. However, fruit containing less than 30 per cent moisture kept for 45-100 days before spoilage occurred. Dehydrate to moisture contents of 28 per cent to 30 per cent if fruit is

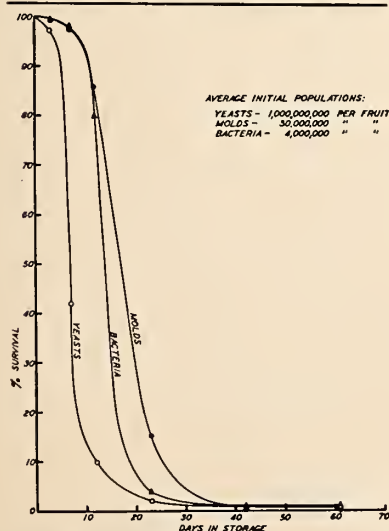


Figure 3. Survival of microorganisms occurring naturally on Khadrawy dates in cold storage. (28°-32° F.)

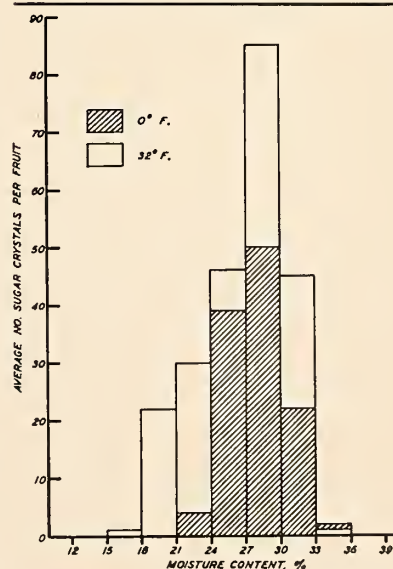


Figure 4. Effect of moisture content and storage temperature upon the formation of sugar spots in Maktoom dates.

- to be consumed within forty days after removal from cold storage. Light colored fruit can be marketed with a slightly higher moisture content than darkened fruit.
7. Considerable sugar spotting of dates occurs in the range of 18 per cent to 33 per cent moisture. Fruit must be stored at 0° F. or lower to maintain this type of spoilage at a minimum.

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OFF-TYPE PALMS IN COMMERCIAL DATE GARDENS

By Roy W. Nixon¹

U. S. Date Garden, Indio, California

After a commercial date garden has come into bearing it often happens that a few off-type palms are discovered. If there are striking differences in fruit or foliage such palms may attract attention and be replaced at a relatively early age. In some instances, however, the differences between off-type and normal palms are slight and not noticed until the palms have reached full production, after which replacement is difficult.

A situation of this kind was recently called to my attention by H. L. Cavanagh. In his date garden near Indian Wells, Mr. Cavanagh has observed six palms which have consistently produced fruit of lower than average quality. The dates, like the palms from which they come, readily pass for Deglet Noor, but as they approach maturity slight differences begin to show up. The first difference is noted in the khalal stage when the color of the fruit of the off-type palms is a shade deeper than the normal light red of Deglet Noor. The color of the off-type fruit, as matched with Ridgway's (4) standards, is near "dragons-blood red," whereas the prevailing shade of Deglet Noor fruit is close to "carnelian red."

As it ripens, a large percentage of the fruit on the off-type palms is found to be affected with checking, blacknose, shrivel, and rot; this fruit shows a pronounced tendency to darken and shrivel at the tips. A dull, muddy-brown color is associated with checking. In the several lots of fruit examined there were at least some specimens from the off-type palms that were indistinguishable from Deglet Noor, but the perianth was usually a little lighter yellow in color, was slightly less prominent, and averaged slightly less in diameter (about 0.5 mm.). It was also evident that the fruit on the off-type palms

was a little later than the Deglet Noor in ripening as indicated by the larger proportion of khalal fruit at the time of examination. The differences found in the fruit were not greater than might possibly be attributed to some unfavorable environmental condition of the palms in question, but the fact that these palms are scattered among others in a well-cared-for and otherwise uniform block makes this possibility extremely unlikely.

The foliage of the off-type palms shows no differences that would attract the attention of a casual observer. However, close inspection and measurements showed that leaves of the off-type palms as compared with those of Deglet Noor are slightly shorter (1 to 1.5 ft.) and the pinnae are a little shorter (as much as two inches) and slightly broader (about 1/16 inch) and droop less. Leaves on the off-type palms have one character that seems to be of special diagnostic value as it is consistent on all the palms examined and can be easily seen at close range at any time of the year. This is the presence of a moderate to considerable amount of scurf (fine, bran-like scales) on the midribs of leaves of last year's growth. This scurf occurs mostly in the spine area and lower leaflet zone on the under side of the midrib, or the side away from the palm and most readily seen by an observer. There is a slight amount of scurf on the midribs of Deglet Noor date leaves but the difference in quantity is striking.

This particular off-type palm is described in detail because it is believed to be scattered in other Deglet Noor gardens. At the U. S. Date Garden, three palms of the same type occur in one row of one block and two palms in another block. In talking with different growers I learned that apparently several have recognized and removed similar palms from their own gardens. It is likely that there

are other specimens that have not yet been discovered.

The original source of most off-type palms is believed to be seedlings which come up near the base of a young palm. Seedlings have a different type of leaf during the first year or two but later they are easily mistaken for offshoots. Sometime ago a date grower phoned me that he had a Deglet Noor palm with two large offshoots bearing male flowers. He said he was about to destroy these offshoots but that, if I would like to see them, he would wait until I arrived. I asked him not to cut the connection before I got there and hurried out to take a look. On opposite sides of a Deglet Noor palm about 5 years old there were what appeared to be two large offshoots. There were no apparent differences in foliage that would distinguish these alleged offshoots from the Deglet Noor variety but both of them were bearing male inflorescences. However, when the dirt and roots were carefully removed from around their bases, the apparent offshoots were easily pulled out and it was obvious that they had no connection with the Deglet Noor palm by which they were growing.

Yet it would have been very easy in cutting the roots with a chisel, as is usually done, to slice off a piece of the base of one of these seedlings and without a close inspection to determine whether a connection was severed on the trunk of the palm by which it was growing, it could easily have been mistaken for an offshoot. Laborers working without close supervision on a hot day in May or June are not likely to be concerned about such a mistake. One seedling palm, planted by mistake as an offshoot, may be the source of a considerable number of off-type palms, because most offshoots of the off-type palm are likely to be removed before it has come into full bearing and

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attracted the attention of the owner.

The term "satellite seedling" was applied by Mason (1) to any seedling palm near enough like the parent to be included commercially with the variety. In his studies of the Hayany variety in Egypt he found a "small-fruited" type and a "late-ripening" type which could not otherwise be distinguished from the true, large, early-ripening type. It is very likely that satellite seedlings can be found in any variety that has been extensively planted. What are probably two satellite seedlings of Deglet Noor in Coachella Valley have already been reported (3). One is distinguished by very late ripening and the other by a yellow khalal color; otherwise both the palms and the fruit readily pass for those of true Deglet Noor. The distinguishing characters of both of these off-type strains appear in palms grown from their offshoots. This, of course, is the final test as to whether slight differences are genetic or the result of some physiological disturbance caused by changes in environment.

While it is believed that most off-type palms that occur in commercial date plantings are seedlings that have been mistaken for offshoots, there is also the possibility that some of them may have originated as bud variations, or, what is better termed in the case of the date palm, sectorial mutations. Sectorial mutations of the date palm have been described by Mason (2) and by Shamel (5). I have seen several. In a typical sectorial mutation different characters of fruit or leaves or both are possessed by one sector of the palm, usually occupying about a third of the trunk circumference and showing a vertical line of demarcation between the normal and mutant parts. A leaf or a fruitstalk which happens to straddle this line of demarcation will be partly normal and partly mutant. Offshoots in the mutant sector will possess the mutant characters and may perpetuate them. I recall one particular Deglet Noor sectorial mutation brought to my attention about 20 years ago. In this instance the chief character of the mutation was the inability of its flowers to set fruit, a defect found to have been transmitted through offshoots to other palms grown from it. While the several sectorial mutations that have been observed in the Deglet Noor variety have all been inferior to the parent type, it is possible that a superior strain of the Deglet Noor or of any other variety might originate as a sectorial mutation.

The occurrence of off-type palms in commercial date plantings emphasizes the need for care in cutting and handling offshoots to make sure that no seedlings or mutations are planted by mistake and for early and frequent

inspections of young palms to detect off-type specimens as soon as possible. If an off-type palm can be detected within the first six years after planting it is possible to replace it with a large nursery palm which can be expected to make fair growth, but after that time it becomes increasingly difficult to get satisfactory growth of replants. The presence of inferior off-type palms in commercial plantings represents a definite loss that the grower can ill afford.

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A Method for Removing Non-Commercial Date Palms By R. S. Dillman

Date Grower, Bard, California

During 1952 we took out 12 acres of 20-year-old Khadrawy palms planted 60 to the acre at a cost of \$135.00 per acre. We had tried several different methods for removing palms. Our real failure was caused by cutting trunks at ground level with a chain saw. We are still troubled by some of the trunks after five years.

The following method was used in removing the 12 acres in 1952:

First Operation: Digging a narrow trench around palm trunk fourteen inches deep below general ground level, cutting all roots close to the trunk, using axe, grub hoe and shovel. *Time:* One workman 1½ hours.

Second Operation: Cutting groove or channel in trunk at bottom of trench with axe so that palm trunk would break at that point. *Time:* One workman 15 minutes.

Third Operation: putting chain around crown of palm and connecting with tractor, pulling palm over, breaking trunk at groove. *Time:* One workman 10 minutes, tractor 10 minutes.

Fourth Operation: Backing palm-hauling "A" frame over trunk butt; raising same from ground and start-

ing to burn ground. *Time:* One workman 10 minutes, tractor (round trip) 20 minutes.

Fifth Operation: Filling hole with bulldozer. *Time:* tractor 10 minutes.

For a major operation with a large acreage of palms to be removed experienced users of compressed air equipment tell me the digging operation could be done with a suitable air tool at a lower cost than we obtained. The very important point is to break off the heart of the trunk at a point below the plow zone. In our case some of the hearts did not break clean and left a part that had to be cut off with axes or burned off with old leaf bases.

With equipment heavy enough to haul off the green palms the above method allows immediate planting of a new crop.

DATE PRODUCTS EXPERIMENTS

By W. V. Cruess

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University of California,
Berkeley

Some experimental work has been continued during the past year on utilization of lower grade dates.

A canned date-nut filling for use in layer cakes has been studied at the suggestion of Eugene Jarvis of Associated Date Growers and Packers. Finely ground dates or Associated's date-milk-shake paste, water, invert syrup, a small amount of citric acid, and chopped walnuts were the principal ingredients. The filling is of about 65 per cent sugar content and of easily spread consistency.

Further studies were made on the clarification and filtration of date table syrup; preparation and use of vacuum dried date pieces; date candies; date granules and date-grapefruit juice in canned form. The FAO organization in Iraq asked for samples of canned date-grapefruit juice, as there is considerable interest in this product in that area.

Mr. W. H. Tappan, who provided a research grant for this research several years ago, is still interested in the possibility of developing free flowing date pieces of irregular form and somewhat smaller in size than date rings.

As in all new food products work the critical hurdle is to find some one willing to produce and market a new date product. It costs real money and requires a sustained sales introduction and marketing campaign. It can be done if the right product is promoted, as is amply proven by the tremendous growth of frozen orange concentrate in the past five years. Its production now exceeds that of all other frozen fruits combined.

FACTORS AFFECTING THE SPOILAGE OF DATES AT ROOM TEMPERATURE

By G. L. Rygg, J. R. Furr, R. W. Nixon and W. W. Armstrong

Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture

The intimate relation between the moisture content of dates and their susceptibility to spoilage from fermentation and mold has long been common knowledge. Cleveland and Fellers (1) reported as long ago as 1932 that 23 per cent moisture marked the dividing point between dates that were self-preserving and those that would spoil as a result of the activity of yeast or molds if suitable species were present.

The beneficial effect of refrigeration on the retention of good quality in dates is well known. The experiments described herein were designed to give information on the nature and extent of deterioration that might be expected in dates during the portion of the marketing period in which they were not held under refrigeration. Information was sought also on the variation in the amounts of spoilage of different varieties of dates and on the effect of such factors as treatment with fungicidal agents or steam hydration as well as moisture content.

MATERIAL AND METHODS

Thirty lots of dates were prepared for these tests. One-half of these were treated with Fumold, a proprietary preparation composed of 15 per cent ethylene oxide and 85 per cent methyl formate, at the usual commercial rate of one milliliter per pound of dates. The remaining lots were

used for comparison with the treated. Table 1 contains a general description of the lots used. Enough packages of each kind were prepared to allow five replicates to be examined at each inspection. The dates were commercially graded and packed in one-half pound packages, and these were enclosed in moisture-proof cellophane (300 MST). Detailed examination was limited to five fruits from each of the five packages at each inspection. These were selected to represent the contents of the packages.

The experimental lots were held without refrigeration in a room where the average temperature for the test periods was 66° F. Ordinary daily fluctuations were about 10 to 15°.

The properties of the dates that were recorded include moisture content, color, pH, odor, flavor, yeast development, and mold. The moisture content of individual dates was measured by preparing a paste of the flesh and determining the refractive index (4). The pH of this paste was measured with a glass electrode pH meter. The colors of the dates were matched with those in Ridgway (3). To give a quantitative means of expressing changes in color, numerical values were arbitrarily assigned to each color. The lightest color was given a value of 1 and the values increased to a maximum of 10 as the

colors became darker. Since the primary objective was evaluation of degree of darkening, each numerical value actually covers a range of slightly different shades, but the following colors in Ridgway's Manual are typical.

The first examination was made within one day of the time of packaging, and succeeding examinations were made at intervals over a period of several months. Since the interval between harvesting and packaging of the different lots varied, the extent of darkening at the time of packaging also varied. Lots were discarded when all or a large portion of the dates examined had spoiled.

The term "spoilage" as used in this report applies to deterioration from fermentation or mold growth or from the development of objectionable odor or flavor from any cause. The gradual deterioration brought about by such factors as darkening, loss of flavor or aroma, sirupiness, or change in texture is not included in the data tabulated under spoilage.

RESULTS AND DISCUSSION

The data in Table 1 show that most of the lots were lacking in uniformity at the time they were packaged. Too often there is fermentation or molding of individual fruits of high moisture content that were inadvertently included in commercial packages of dates supposedly so dry that they could be expected to keep safely until consumed. One such fruit may, as far as the consumer is concerned, spoil the contents of the whole package. More than that, it may deter the consumer from buying more domestically grown dates in the future. The very slow rate of moisture equalization in dates within a package makes it important that a packing house inspector concerned with controlling quality of the pack measure the moisture content of individual fruits rather than that of a composite sample made up of a large number of fruits, since with the latter practice the inclusion of both very wet and very dry fruits may completely obscure the true condition of the sample.

The diversity of pH values of the dates when packaged was not large. The information on the relation between pH and quality is still so meager that one cannot draw rigid conclusions. There is considerable evidence, however, to support the conclusion that all the values recorded at the beginning of these tests were high enough to be satisfactory

Table 1. Ranges of moisture content, pH, and color rating of experimental lots of dates at the beginning of the tests.

[The color ratings are on a 10-point scale; a value of 1 represents the lightest color found on any fruit and the ratings increase as the colors become darker]

Variety and hydration		Moisture content		pH reading		Color rating	
		Low	High	Low	High	Low	High
Nonhydrated:							
Medjool — High moisture		31.0	38.5	5.9	6.3	3	8
Medjool — Low moisture		27.0	39.0	5.8	6.4	4	10
Khadrawy — High moisture		17.5	40.0	6.1	6.8	1	9
Khadrawy — Low moisture		21.6	34.1	6.2	6.5	1	7
Barhee — High moisture		32.2	43.2	6.6	7.2	1	7
Barhee — Low moisture		24.8	36.3	6.3	6.8	2	8
Deglet Noor — High moisture		22.1	30.1	6.2	6.7	2	8
Deglet Noor — Low moisture		22.8	32.1	6.1	6.6	1	5
Deglet Noor — Select dry		13.0	25.7	5.2	6.4	2	5
Hydrated:							
Medjool —		21.2	26.7	5.9	6.2	4	8
Halawy —		23.2	28.2	5.9	6.2	1	5
Halawy —		18.4	24.4	5.9	6.1	1	6
Zahidi —		20.4	24.3	5.5	5.9	4	6
Deglet Noor — High moisture		21.6	31.5			3	5
Deglet Noor — Low moisture		21.6	25.1	5.5	5.7	3	8
Numerical rating	Ridgway color designation	Numerical rating		Ridgway color designation			
1	Raw Sienna, III-17-i	7		Diamine Brown, XIII-3-m			
2	Amber Brown, III-13-k	8		Warm Blackish Brown, XXXIX-I-m			
3	Chestnut, II-9-m			Blackish Brown, XLV-5-m			
4	Morocco Red, I-5-k	9		Dull Purplish Black, L-65-m			
5	Claret Brown, I-5-m	10					
6	Chocolate, XXVIII-7m						

except the lowest pH values in the select dry Deglet Noor. Low pH is often associated with poor quality.

The diversity in color of the dates in several of the samples at the beginning of the experiments (Table 1) may not be serious as far as general quality is concerned, but reasonable uniformity in the color of the contents of each package is highly desirable. Such uniformity increases the attractiveness and therefore the salability of the package.

RELATION OF MOISTURE CONTENT TO SPOILAGE

The spoilage from fermentation or mold development, which became noticeable in some lots within a few weeks after packing, was intimately related to the moisture content in dates not treated with Fumold (Table 2). No spoilage caused by molds or yeasts was found in dates with a moisture content of 21 per cent or less at the time of inspection. These results support the conclusion of Cleveland and Fellers (1) that dates with less than 23 per cent moisture are self-preserving. Possibly some of the fruits examined had lost a small amount of moisture after spoilage had developed and before they were inspected. In this event the actual spoilage at a given moisture content would be slightly less than that given in Table 2.

Table 2. Relation between moisture content at time of inspection and spoilage from mold and fermentation during storage in all experiments without Fumold.

Moisture content ¹	Fruits examined	Fruits spoiled
Per cent	Number	Per cent
21	70	0
22	118	1.9
23	197	2.6
24	118	9.2
25	70	15.9
26	72	29.1

1. The moisture content indicated is the mid-point of a class; that is, dates placed in the 21 per cent class ranged between 20.6 and 21.5 per cent moisture.

Varieties may differ in the moisture content-spoilage relation (Tables 3 and 4). In Table 3 Deglet Noor and Khadrawy dates are compared over a moisture content range of 21 to 30 per cent. The number of fruits at each moisture value was fortuitous because the moisture contents could not be selected in advance, hence the large variability in this respect. These data suggest that Deglet Noor dates may be somewhat more susceptible to spoilage than Khadrawy. The reason for this is not known. Differences in types of sugars in the two varieties are offered as one explanation. The

Table 3. Comparison of spoilage in Khadrawy and Deglet Noor dates over a range of moisture contents with and without Fumold.

Moisture Content	Fruits examined				Fruits spoiled			
	Without Fumold		With Fumold		Without Fumold		With Fumold	
	Kha-drawy	Deglet Noor	Kha-drawy	Deglet Noor	Kha-drawy	Deglet Noor	Kha-drawy	Deglet Noor
Per cent	Number	Number	Number	Number	Per cent	Per cent	Per cent	Per cent
21	2	5	18	7	0	0	0	0
22	2	13	16	47	0	23	6	0
23	22	27	27	66	0	11	0	8
24	23	13	32	54	13	23	16	0
25	14	25	26	28	36	52	0	32
26	19	26	38	12	47	27	11	0
27	22	9	28	16	41	56	4	6
28	15	14	21	0	67	86	5	..
29	14	6	11	0	29	100	0	..
30	7	1	5	0	100	100	0	..

Table 4. Comparison of spoilage in Barhee and Medjool dates over a wide range of moisture contents with and without Fumold.

Moisture content	Fruits examined				Fruits spoiled			
	Without Fumold		With Fumold		Without Fumold		With Fumold	
	Barhee	Medjool	Barhee	Medjool	Barhee	Medjool	Barhee	Medjool
Per cent	Number	Number	Number	Number	Per cent	Per cent	Per cent	Per cent
24	0	4	3	1	..	0	0	0
25	2	1	9	25	0	100	0	0
26	6	20	0	24	0	40	0	0
27	9	14	10	25	11	50	0	0
28	5	23	24	26	0	30	0	0
29	24	18	26	14	54	44	0	14
30	16	10	39	11	19	30	0	0
31	39	7	39	8	23	86	0	25
32	24	9	17	6	4	67	0	17
33	15	19	13	24	47	79	0	33
34	27	29	26	29	19	62	0	7
35	12	10	15	19	8	80	0	5
36	5	33	9	18	40	91	0	12
37	4	15	5	9	0	100	20	11
38	4	4	4	2	25	100	0	0
39	5	7	3	2	0	100	0	0
40	1	2	2	0	100	100	0	..
41	0	0	2	0	..	..	0	..

predominant sugar in Deglet Noor dates is sucrose, whereas reducing sugars make up virtually all the sugar in Khadrawy dates. Molecules of sucrose are nearly twice as large as those of reducing sugars. Consequently, a given weight of sugar from Deglet Noor dates has fewer molecules than the same weight of sugar from Khadrawy. This is significant because the number of sugar molecules in a given volume of solution rather than their size determines the osmotic pressure, or availability of water, and therefore the ability of microorganisms to thrive. The kind of sugar may also exert other influences besides that of osmotic pressure.

The kind of sugar found in Deglet Noor and Khadrawy dates may or may not account for the difference in amount of spoilage but it cannot explain the difference noted between Barhee and Medjool (Table 4). The sugar in both of these varieties is largely or entirely in the hexose, or reducing sugar, form. Varietal differences in tendency to spoil were also noted by Sharples (5).

COMPARISON OF SPOILAGE OF HYDRATED AND NON-HYDRATED DATES

The hydrating process used on the Deglet Noor dates improved the keeping quality of the fruit in comparison with that of nonhydrated fruit of the same variety and moisture content (Table 5). The difference between these two groups in their tendency to spoil is undoubtedly due to the killing of the microorganisms on and in the dates during the hydration process, which consisted of exposing the dates to live steam at 175° F. for one-half hour and then at 140° for two and one-half hours. Sharples (5) found that most of the yeasts were killed by holding the dates at 165° F. for 30 minutes, but only a few of the molds and bacteria were killed.

EFFECT OF FUMOLD ON SPOILAGE

The use of Fumold was very effective in most instances in reducing or preventing microbiological spoilage in most dates (Tables 3 and 4). Instances in which this treatment was ineffective may sometimes have been the result of the escape or inactiva-

Table 5. Relation of moisture content to spoilage from mold and fermentation in nonhydrated and hydrated Deglet Noor dates not treated with Fumold.

Moisture content and hydration	Fruits spoiled at indicated inspection			
	Second*	Third†	Fourth‡	Fifth§
	Per cent	Per cent	Per cent	Per cent
21 per cent:				
Nonhydrated	0	..	0	..
Hydrated	0	0	0	0
22 per cent:				
Nonhydrated	0	0	50	..
Hydrated	0	0	0	0
23 per cent:				
Nonhydrated	0	0	100	..
Hydrated	0	0	0	..
24 per cent:				
Nonhydrated	17	100	67	..
Hydrated	0	0	..	..
25 per cent:				
Nonhydrated	20	0	100	..
Hydrated	0	..	..	..
26 per cent:				
Nonhydrated	20	0	100	..
Hydrated	0	..	..	..

*22 days after packing for nonhydrated and 30 days for hydrated.

†65 days after packing for nonhydrated and 71 days for hydrated.

‡105 days after packing for nonhydrated and 107 days for hydrated.

§162 days after packing for hydrated; nonhydrated discarded after fourth inspection.

tion of the fumigant before the organisms were killed, but they could also be the result of inadequate penetration of the fumigant through the contents of the packages.

Khadrawy dates that were treated with Fumold were held as long as 199 days and nontreated ones as long as 172 days. Treated Deglet Noor dates were held as long as 197 days and nontreated ones 148 days. Treated Barhee dates were held as long as 188 days and nontreated ones 133 days. Treated Medjool dates were held as long as 154 days and nontreated ones 117 days. In the nonhydrated lots not included in Tables 3 and 4 treatment with Fumold consistently reduced loss from fermentation and mold. An exception was the select dry Deglet Noor, which was so dry that no spoilage was found even in the absence of Fumold treatment. All the dates that were hy-

drated but not treated with Fumold kept so well that no noticeable improvement was produced by the treatment. Sharples (5) found that the yeast population was materially reduced by fumigating with carboxide at the rate of 8 pounds per 1000 cubic feet for 16 hours. Molds and bacteria were reduced only slightly. The active ingredient in carboxide is ethylene oxide.

When properly used, Fumold is helpful in preventing or reducing spoilage in dates while they are being marketed. However, if too large quantities are used the flavor of the fruit is permanently impaired. There is also a tendency for packers and handlers to assume for the treated dates a degree of immunity from spoilage that does not really exist. As a consequence, these dates are not given the careful handling and good refrigeration which they might

otherwise be accorded. Dates that are moist enough to be benefited very appreciably by treatment with Fumold or any similar agent are likely to deteriorate rapidly from causes other than molding and fermenting when they are held at ordinary temperatures. Loss of flavor, if not the actual development of off-flavors, takes place at a rate somewhat proportional to the moisture content. Moist dates also become dark, and the escaping juice soaks into the containers and smears transparent bags and overwraps. Fumigants for the control of mold and yeast activity do not affect these forms of deterioration and they should therefore be used in conjunction with, rather than as a substitute for, good refrigeration practices. If sufficient refrigeration for the retention of good quality in moist dates cannot be provided, the dates should be dried to a moisture content at which they will retain good flavor and appearance under the storage conditions that can be provided.

CHANGES IN pH VALUES DURING STORAGE

The pH values of nearly all the nonhydrated dates used in these tests (92.5%) were 6.0 or higher at the beginning of the experiments. Values in this range are usually associated with good grades. Many of the dates in the hydrated lots had lower initial pH values. These lower values are typical of grades that require hydration before they are marketed.

The pH readings of the date flesh decreased during storage. This decrease was greater in fermented dates than in those that remained sound. Molded dates usually were not more acid than sound ones in the same sample, but readings as low as 3.35 were found in fruits that had fermented and soured. The pH values of sound hydrated dates decreased as much in storage as those of sound nonhydrated ones of the same variety (Table 6).

The low pH of fermented and sour dates as compared with sound ones in the same lot was presumably caused by organic acids formed by the activity of microorganisms. However, the cause of the lower pH values of dates classed as sound has not been determined. Much work needs to be done on the acids in dates before this question can be answered. Perhaps the "slow or incipient fermentation" mentioned by Mrak (2, page 4) as taking place in undercured dates is responsible. If this explanation is correct, the increase in acidity may serve as a measure of the deterioration which the dates have undergone even though the deterioration has not been great enough to produce noticeable off-flavors or off-odors. If this incipient fermentation is the

Table 6. Typical pH values of apparently sound nonhydrated and hydrated dates before and after storage.

Hydration and variety	Packing house designation	pH at start	pH at end of storage		Days in storage	
			Without Fumold	With Fumold	Without Fumold	With Fumold
Nonhydrated:						
Medjool—High moisture		6.1	5.9	5.7	34	117
Medjool—Low moisture		6.1	5.9	5.3	34	154
Khadrawy—High moisture		6.7	5.9	5.5	111	148
Khadrawy—Low moisture		6.4	5.9	5.3	116	153
Barhee—High moisture		7.0	6.0	5.5	105	142
Barhee—Low moisture		6.6	5.6	5.3	133	188
Deglet Noor—High moisture		6.5	5.9	5.5	103	194
Deglet Noor—Low moisture		6.4	6.2	5.2	23	197
Deglet Noor—Select dry		6.0	5.1	5.0	188	188
Hydrated:						
Medjool—		6.0	5.2	5.2	175	175
Halawy—		6.1	5.3	5.1	153	208
Halawy—		6.1	5.4	5.4	175	175
Zahidi—		5.7	5.1	5.0	206	206
Deglet Noor—High moisture		..	5.4	5.3	161	161
Deglet Noor—Low moisture		5.7	5.3	5.2	162	162

cause of the lowered pH and if it is produced by sugar-tolerant yeasts or by bacteria, these organisms must have been so deeply imbedded in the flesh that they were not reached by the fungicidal fumigant or they were of kinds more tolerant to this gas than those that cause the kind of fermentation ordinarily found in dates. These organisms would also have to be more tolerant to high temperatures than those ordinarily associated with fermentation or molding. The results obtained by Sharples (5) suggest that bacterial survival after the treatments with heat or Fumold is sufficient to account for the increase in acidity noted.

COLOR CHANGES IN STORAGE

The color changes that occurred in stored dates can be expressed in only a semiquantitative manner. It is difficult to evaluate slight differences in color by means of charts, as the appearance of a color in the fruit is affected by differences in texture, irregularities of skin, cleaning treatment, and variations in the light under which it is examined. The results of this study, however, are consistent enough to indicate certain trends. The ratings given in Table 1 show that there was considerable variation even at time of packaging. The rate of color change was most rapid during the early period of storage, and the fact that some dates had already reached almost the maximum darkening at the first inspection suggests that the color change may have been even more rapid during the interval between ripening and packaging than after packaging.

Where this diversity was most marked within a given lot at one inspection, as with the Barhee variety, the lightest colored dates were found to have a lower moisture content than the darkest ones. This may be taken as evidence that a fruit with high moisture content darkens more rapidly than one with a low moisture content. At the first inspection the average color of the dates in lots with low moisture content was darker than that of the dates in lots with high moisture content. The dates with low moisture content at the time of packaging probably represented fruit that had ripened earlier and had been allowed to dry for a longer period of time on the palm or in the packing house than those with high moisture content. The select dry Deglet Noor is in a different category from the other lots, for this fruit dried on the palms as it ripened.

That there are varietal differences in rapidity and degree of darkening is shown by the differences between the initial color rating and the final color rating in nonhydrated fruit. The greatest spread occurred in Barhee and Medjool and the least in Kha-

Table 7. Average color rating of all dates of all lots at the beginning and end of storage.

[The color ratings are on a 10-point scale; a value of 1 represents the lightest color on any fruit and the ratings increase as the colors become darker]

Hydration and variety	Packing house designation	Initial color rating	Final color rating		Days in storage	
			Without Fumold	With Fumold	Without Fumold	With Fumold
Nonhydrated:						
Medjool—High moisture		5.6	9.1	8.4	117	117
Medjool—Low moisture		6.1	8.4	9.1	117	154
Khadrawy—High moisture		4.6	6.2	8.0	111	148
Khadrawy—Low moisture		4.4	6.9	7.8	116	153
Barhee—High moisture		3.2	8.8	8.9	105	142
Barhee—Low moisture		4.7	8.8	7.8	133	188
Deglet Noor—High moisture		3.2	5.9	6.9	103	194
Deglet Noor—Low moisture		2.3	6.4	7.4	106	197
Deglet Noor—Select Dry		3.0	3.7	3.9	188	188
Hydrated:						
Medjool—		6.7	7.2	7.7	175	175
Halawy—		2.7	5.8	5.4	153	208
Halawy—		4.3	5.3	6.2	175	175
Zahidi—		5.4	6.1	5.8	206	206
Deglet Noor—High moisture		4.1	6.7	6.6	161	161
Deglet Noor—Low moisture		3.4	6.4	6.4	162	162

drawy, but it would not be safe to attempt a final evaluation of varieties in this respect until uniform samples are observed from the time the dates ripen on the palm until the end of the storage period.

The results show that darkening of the fruit takes place independently of spoilage as defined in this paper. Dates just as dark as any that were spoiled were repeatedly found to have no evidence of mold, fermentation, or disagreeable flavor. Yet any consumer accustomed to the light amber color of Deglet Noor or Barhee would not be pleased by the nearly black color of the fruits after long storage. Furthermore, while these dates were not found to have a disagreeable flavor and were edible, to one familiar with the dates at all stages the pleasing flavor and the aroma associated with the lighter colored fruit were lacking. These changes constituted a deterioration which must be considered in marketing.

Since the pH readings decreased and the color darkened in stored dates, a correlation between these two values might be expected. Such correlation was found in many lots. A statistically highly significant correlation was found in 19 lots, a significant correlation in one, and no significant correlation in the remaining ten.

The relative rates of change of

color and of pH values in stored dates were different. Consequently, the typical pH value associated with the given color rating became lower as the storage period progressed. An example of this change is presented in Table 8, which gives the results obtained from moist Barhee dates treated with Fumold. Not only did the pH readings usually decrease as the color ratings increased, but the pH typical for a given color rating usually decreased with succeeding inspections. Treatment with Fumold did not consistently influence the rate of darkening.

SUMMARY

Dates of six varieties with moisture contents ranging from 13 to 43 per cent were stored at ordinary room temperature for various periods up to 208 days.

Observations were made on moisture content, color, pH value, odor, flavor, yeast development, and mold.

The high degree of diversity found at the beginning of the experiments in commercially graded dates emphasizes the need for greater uniformity within each packinghouse designation or grade. A wide range of moisture content of dates within a package is objectionable. Even one or a few very moist dates in a package may spoil and make the entire package unacceptable to the consumer.

Table 8. Typical pH values associated with the various color ratings at each inspection of high moisture nonhydrated Barhee dates treated with Fumold.

[The color ratings are on a 10-point scale; a value of 1 represents the lightest color on any fruit and the ratings increase as the colors become darker]

Inspection number	pH for indicated color rating									
	1	2	3	4	5	6	7	8	9	10
1	7.0	..	6.9	..	..	..	6.7	..	..	..
2	..	6.6	..	..	..	6.5	..	6.3	..	..
3	..	..	..	..	6.4	6.3	..	..	..	6.2
4	..	..	..	..	..	..	..	5.9	..	5.9
5	..	..	..	..	..	5.5	..	5.5	..	5.4

Spoilage increased rapidly as the moisture content increased above 23 per cent.

Steam hydration of dates gave a product less subject to spoilage than nonhydrated dates of the same variety with the same moisture content.

The application of Fumold, a mixture of 15 per cent ethylene oxide and 85 per cent methyl formate, was effective in reducing such spoilage in moist dates as is caused by microorganisms. Its usefulness is limited, however, because dates that are subject to spoilage from this cause are also subject to deterioration from darkening, loss of flavor, and development of sirupiness if they are not refrigerated. Fumold does not prevent or retard such deterioration.

Data are presented indicating that an increase in the acidity of the flesh of dates often accompanies spoilage and darkening.

Color darkened progressively as the storage period was increased.

There was evidence that moist dates darkened more rapidly than drier ones of the same variety.

CONCLUSIONS

These studies point to two ways of improving the quality of non-refrigerated dates offered to the consumer; improved grading to reduce variation in the moisture content of the fruits in a package and reducing average moisture content of the pack to the lowest level at which the texture (softness) of the dates is acceptable to the consumer. In the Deglet Noor this would probably be a moisture range of about 23 to 25 per cent, depending upon the condition of the flesh. Dates marketed with a higher moisture content should be held under refrigeration.

Steam-hydrated dates are less likely to spoil from molding or fermenting than comparable nonhydrated dates with the same moisture content.

Dates treated with Fumold are less likely to spoil from molding or fer-

menting than comparable nontreated dates with the same moisture content, but Fumold should not be used as a substitute for refrigeration as a means of preventing deterioration of moist dates, but rather as a complement.

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EXPERIMENTS ON THE CONTROL OF INSECTS INFESTING DATES IN THE BUNCH

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Insects infesting dates in the Coachella Valley were relatively abundant during the 1952 season and remained active well into October. In a single Khadrawy date garden at Indio the infestation of dates by nitidulid beetles was as high as 19 per cent early in the season and dropped to eight per cent late in the season; in this same garden infestations by pyralid moths (the raisin moth and the Indian meal moth) ranged from 0 per cent early in the season to 18 per cent late in the season. These percentages are based on all dates from the bunches, including culls and drops, and does not represent the infestation that would be found in a commercial picking.

In several Deglet Noor gardens where culls and drops were included in the samples checked, infestation by nitidulid beetles ranged from seven per cent to 40 per cent. The beetles were abundant from mid-August to late October. Where picking was not too frequent, infestations by the raisin moth and the Indian meal moth gradually increased throughout the picking season. Nitidulid beetles generally prefer moist, souring dates, while the moth infestations occur when the dates are relatively dry, but infestations of both moths and beetles tend to build up with infrequent pickings.

A trace of rain on July 24 and some precipitation on September 19 and 22 did not seem to affect greatly the insect population in dates. As a matter of fact, there were more shriveled dates than normally occurs. The dry condition of the crop, in general, was reflected in the relatively high infestation by moths, and this became worse as the season progressed.

Results in 1951 indicated that a two per cent parathion dust (an organic phosphate insecticide) applied at the rate of 50 pounds per acre not later than three weeks before picking effectively reduced the insect population and infested fruits in the bunch (1). Since parathion is not recommended for use on dates because of the hazards to persons applying this material, several organic phosphates less toxic to warm-blooded animals were tested in the laboratory for their effectiveness against insects infesting dates. These tests indicated that a four or five per cent malathion dust was about as effective as a two per cent parathion dust against insects infesting dates. Available information indicates that malathion is much less hazardous to warm-blooded animals than parathion. Heptachlor (a chlorinated hydrocarbon) was also included in tests on Deglet Noor dates.

PROCEDURE AND

EXPERIMENTAL RESULTS

During the 1952 season, field tests were conducted on Khadrawy, Med-

jhoor, and Deglet Noor dates in various locations throughout the Coachella Valley. Five per cent malathion dust was applied at different intervals prior to picking to determine its effectiveness under field conditions. Deglet Noor bunches were covered with paper bags prior to dusting with malathion. Khadrawy bunches were wrapped with cheesecloth, and Medjhoor bunches were covered with either paper bags or cheesecloth, after application of the dust. Dust applications were made with a hand applicator and were probably heavier than would be used commercially. Date samples for checking insect infestation were obtained by shaking the bunch and collecting the drops into a tray which included culls as well as some sound fruit. The culls, consisting mostly of spoiled fruit, were included in the samples since these dates are attractive to nitidulid beetles and, when present, are usually heavily infested. The number of live and dead insects and of infested fruits were determined for each sample. Samples were picked at intervals to determine the insecticidal residue on the dates and the effect of the insecticide on taste, if any.

Khadrawy dates. Results of applications of five per cent malathion dust and of two per cent parathion dust applied to Khadrawy dates on August 14, 1952, are given in Table 1. Approximately 150 bunches were used in this experiment. Samples were

1. The writers wish to express their appreciation to various date growers, packing house operators, and the U. S. Date Garden for their cooperation.

Table 1. Effect of various insecticidal treatments on insect infestation of Khadrawy dates at Indio, California.

Weeks between treatment and picking	Number of nitidulid beetles in fruit						Per cent fruit infested with						
							Nitidulid beetles			Pyralid moths			
	Untreated (control)		Dusted with				Untreated (control)	Dusted with		Untreated (control)	Dusted with		
Alive	Dead	5% malathion	2% parathion	5%	2%	malathion		parathion	5% malathion		2% parathion		
1	220	41	0	190	0	231	18.8	18.2	11.6	0	0	0	
2	622	18	0	440	0	736	12.8	9.5	9.1	0.3	1.1	0	
3	211	13	0	270	0	203	10.7	6.0	7.6	0.8	0	0.1	
4	597	11	0	117	0	113	13.6	1.7	2.6	5.3	0	0	
5	101	4	0	57	0	90	8.5	0	1.4	7.0	0	0	
6	135	0	0	0	0	8	20.2	0.3	1.8	8.5	0.3	0.2	

taken at weekly intervals after treatment, each bunch being sampled only once; thus the bunches sampled five and six weeks after treatment had not previously been disturbed, and the entire bunch was mature. Normally, these dates would have been picked more frequently. However, it was the purpose of this experiment to determine how long the date bunches would remain free of insects after treatment without being disturbed. It will be noted from Table 1 that in those bunches treated with five per cent malathion or two per cent parathion dusts no live beetles were present, while in the control bunches almost 2,000 live beetles were found. The infestation found in the fruit samples at the one-week interval indicates that the infestation was present prior to treatment. The fruit infested by nitidulid beetles had declined to less than two per cent in the malathion- and parathion-treated bunches six weeks after treatment, while in the control the percentage of infestation remained relatively high.

The percentage of fruit in the control bunches infested by pyralid moths progressively increased (0 to 8.5 per cent), from one to six weeks after treatment while in the bunches treated with malathion and parathion dusts the number of infested fruits remained relatively low (0 to 0.3 per cent).

Deglet Noor Dates. Results of dust treatments on approximately 1,000 bunches of Deglet Noor dates with either 2½ per cent heptachlor or five per cent malathion are given in Table 2. Sampling methods were similar to those used in the Khadrawy plot, and the percentage of infested fruit in-

cludes mostly culls, with some sound fruit that was shaken from the bunch. Each bunch was sampled several times by shaking, and all bunches also received regular commercial pickings by the grower. Four rows of palms were selected in a Deglet Noor garden; the bunches in row 1 were dusted August 21; those in row 2, August 28; in row 3, September 3; and in row 4, September 11. Each row was divided in half, the bunches in one half being dusted with 2½ per cent heptachlor and those in the other half with five per cent malathion, with the remainder of the garden serving as an untreated control.

In Table 2 it may be noted that in those bunches receiving no treatment the number of live beetles found totaled 6,647, while in those bunches receiving a 2½ per cent heptachlor dust 3,093 live beetles were found, and in those bunches dusted with five per cent malathion 38 live beetles were found. The percentage of infested fruits in the control bunches is high since culls and drops made up a majority of the fruits of each sample checked. The same methods were used in sampling the treated bunches however, and the results are therefore comparable.

Infestation by nitidulid beetles was reduced approximately 46 per cent by dusting the bunches with a five per cent malathion dust. In the malathion-treated bunches the number of fruits infested by nitidulid beetles progressively declined as the season advanced (28.9 to 5.6 per cent), while in the control bunches, with the exception of the one-week interval, the infestation remained practically constant (58.5 to 59.4 per cent). Al-

though 2½ per cent heptachlor dust was not as effective as five per cent malathion dust, the former reduced the number of infested fruits considerably.

As the season progressed, the infestation by pyralid moths in the control bunches increased, while in the malathion- and heptachlor-treated bunches it remained relatively low, the infestations in the heptachlor-treated bunches being higher than those in the malathion-treated bunches.

In this same garden, samples of apparently sound fruit that would normally go into the packing house were brought into the laboratory to determine the percentage of "hidden culls"—a term used by the date industry to designate those dates which are difficult to segregate because there is no, or very little, outer, visible indication that the insects or their remains may be or have been in the seed cavity. This type of cull is a serious packing-house problem, slowing up grading operations. Several thousand dates were cut open and examined for evidence of this type of insect infestation. Over six per cent of the fruit from the untreated bunches, slightly less than two per cent from the heptachlor-treated bunches, and less than one per cent from the malathion-treated bunches were found to be hidden culls. In some of the control samples as high as nine per cent hidden culls were found, while in samples from the malathion-treated bunches slightly over one per cent was the highest number found.

Past observations have shown that a few off-type Deglet Noor trees at the U. S. Date Garden consistently

Table 2. Effect of various insecticidal treatments on insect infestation of Deglet Noor dates at Thermal, California.

Weeks between treatment and picking	Number of nitidulid beetles in fruit						Per cent fruit infested with							
							Nitidulid beetles			Pyralid moths				
	Untreated (control)		Dusted with				Dusted with			Dusted with				
Alive	Dead	5% malathion	2½% heptachlor	Untreated (control)	5%	2½%	Untreated (control)	5%	2½%	Untreated (control)	5%	2½%		
1	851	35	0	2086	258	659	82.1	28.9	37.7	0	0	0	0.4	
2	2104	0	0	1677	122	101	58.5	22.0	26.7	0.6	0.6	0.5	0.5	
3	541	0	6	623	89	222	65.4	19.9	27.1	1.9	0	1.2	0	
4	550	14	8	1200	521	230	54.5	14.1	26.2	0	0.2	2.2	0.2	
5	1682	0	13	976	1140	57	58.3	10.7	25.1	2.4	0.2	1.6	0.2	
6	919	12	11	437	963	62	59.4	5.6	25.2	10.3	0	0.9	0	

have a high degree of spoilage and insect infestation from year to year. After it was observed that the bunches on these palms were heavily infested with insects, they were dusted on September 24, 1952, with a five per cent malathion dust to determine the effectiveness of such a dust applied at this time. Samples taken at weekly intervals following treatment showed that many live beetles were found in the untreated bunches, while no live beetles were found in those treated with a five per cent malathion dust. The percentage of infested fruit was found to be as great in the treated bunches as in the untreated, indicating that the fruit had become infested prior to treatment. A treatment applied after the infestation is well established will reduce the live beetle infestation, but will be too late to have much effect on fruit infestation.

It is our observation that beetle activity is usually on the decline after the first to the middle of October, when the weather begins to cool. Results obtained from preliminary experiments on the timing of insecticidal dust applications on Deglet Noor dates during the 1952 season indicate that the most effective time of treatment is not later than three weeks prior to the first picking.

Medjool Dates. A five per cent malathion dust was applied to Medjool dates in three gardens in different areas in the Coachella Valley. No live beetles or infested fruit were found in samples of the treated dates.

Insecticidal Residue Analyses. Two-pound samples of Deglet Noor dates treated with a five per cent malathion dust were picked at weekly intervals following application to determine

the malathion residue present. The samples were collected by cutting the dates directly from the bunch into glass jars, thus preventing any handling of the dates prior to analysis. Both unwashed and washed dates were analyzed, thus giving an indication of what happens during the washing process in the packing house. A total of 20 analyses for malathion were conducted by Dr. F. A. Gunther, insect toxicologist, Citrus Experiment Station, Riverside. Results of these analyses are presented in Table 3. It can be seen that two weeks after application the malathion residue in unwashed dates was slightly less than two parts per million. The malathion

Table 3. Results of chemical analyses of Deglet Noor dates dusted with 5 per cent malathion.

Number of weeks after treatment	Malathion* (parts per million)	
	Unwashed fruit	Washed fruit
Control	0	0
1	3.25	0.67
2	1.96	0.47
3	1.25	0.47
4	1.06	0.58

*Average of two replications

residue on washed dates was less than one part per million.

Dates treated with an insecticidal dust should be washed before marketing, both from the standpoint of residue present and appearance. In general, all Deglet Noor dates are washed before reaching the market; many of the softer varieties reach the market without being washed.

Flavor Evaluation. Prior work has indicated that certain insecticides impart an off-flavor to dates when applied to them (1). Taste tests were therefore conducted on Khadrawy and Deglet Noor dates that had been dusted with a five per cent malathion dust, to determine whether there was any off-flavor due to the presence of malathion. Dates sampled at weekly intervals following treatment were submitted to a taste panel that has been set up in the Department of Entomology of the Citrus Experiment Station at Riverside under the direction of Dr. W. H. Ewart. In no case could any differences in flavor be detected between treated and untreated dates.

SUMMARY

Experiments during the 1952 season indicated that the number of live beetles and the percentage of infested fruits were reduced by the use of a five per cent malathion dust applied at the rate of 40 to 50 pounds per acre not later than three weeks prior to the first picking.

Analyses on dates dusted with five per cent malathion indicated that the residue on unwashed dates was slightly less than two parts per million, and on washed dates less than one part per million.

No difference in flavor could be detected between untreated dates and dates dusted with five per cent malathion.

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OBSERVATIONS ON DATE CULTURE IN ISRAEL*

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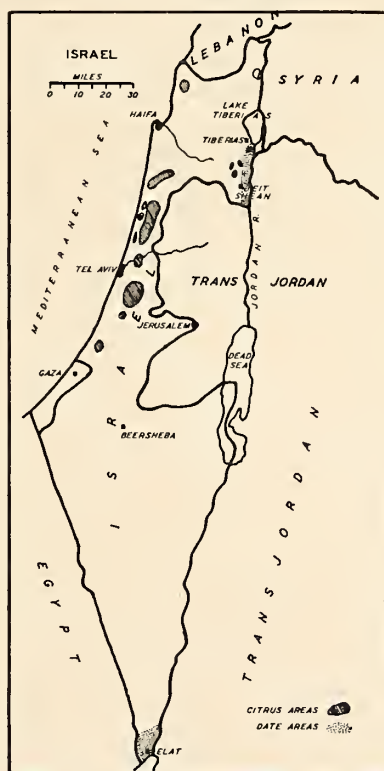
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The present date industry in Israel is relatively new although the date palm has been grown in this area for probably 25 centuries. Beginning about 25 years ago off-shoots of named commercial varieties were imported from Iraq, Egypt, Tunisia and the United States. About 12 gardens were established from these importations. Thus, these gardens are in reality simply variety trials which include the following varieties: Amri, Amhat, Barhee, Deglet Noor, Halawy, Hayany, Khadrawy, Kustawy, Khalasa, Maktoom, Saidy, Samany, Sayer, Zahedi and Zagloul. The performance of many of these is almost exactly the same as has occurred in the United States. For example: Checking and blacknose are serious problems with the Hayany and Deglet Noor; the Sayer has many inflorescences broken from V notches on the fruiting arm, and the Zahedi tends to shrivel as it ripens. At present it appears that the Khadrawy, Halawy, Deglet Noor and Zahedi are best adapted to their conditions and a total of about 200 acres recently have been planted at about 25 cooperative settlements.

CLIMATIC CONDITIONS IN PRODUCING AREAS

Date culture presently centers around the lower portion of Lake Tiberias, near the outlet of the Jordan River and on the terraces west of the Jordan River back as far as Beit Shean (see map). Elevations in this zone range from 730 to 440 feet below sea level. A potential area exists near Elat in the broad Wadi near the Red Sea where a few seedling palms are now growing.

In the Jordan area temperatures are markedly lower during midsummer and higher in the spring and fall than in the U. S. date growing areas. In the Elat area higher temperatures are encountered throughout the year. Mean annual precipitation in the Jordan-Beit Shean zone ranges from 12-16 inches. At Elat it is 1 inch. All precipitation occurs between September and May, with about 80 per cent of it occurring between December and March. Thus, rainfall does not present a hazard to the date industry. The humidity, in the Jordan area however, appears to be much higher than encountered in the United States date producing areas. Dew occurs on approximately half of the nights in August and September in the lowest sections. Marked differences occur with eleva-



tion, and with the presence of carp ponds, trees, etc., so the micro-climate of each location is of paramount importance in the location of date plantings.

SOILS AND IRRIGATION

The soils in the Jordan areas are clays, clay-loams and loams, which contain large amounts of calcium carbonate and have a high pH. They are moderately deep and date roots penetrate to a depth of eight feet or more. Water is obtained from wells and springs and from Lake Tiberias. However, many gardens close to Lake Tiberias and near carp ponds have a water table within four to eight feet of the surface. One garden I observed had been making good growth since 1945 without irrigation. Some plantings are situated on sloping terrain so the depth to water may vary widely within the same garden. Water is usually applied in furrows or basins, although sprinklers were used in at least two locations.

PROPAGATION

The Israeli growers understand propagation principles very well and a high survival of offshoots is obtained. Based upon past experience, best results are obtained by cutting and planting offshoots in July. From 18 to 30 inches of new leaf growth takes place by late October on offshoots planted about mid-July. All

high offshoots are rooted on the palm prior to cutting. To prevent aerial root development on the parent palm the old leaf bases are cut back close to the main trunk of the parent palm which exposes the offshoot connection. A metal shield is then fitted between the offshoot and the parent palm. The offshoot is then boxed with either a wooden or metal box—frequently an old powder keg was used. The box is filled with wood shavings and sawdust which is kept moist by frequent watering. Excellent root development occurs within six months.

FRUIT GROWTH AND RIPENING IN THE JORDAN BEIT SHEAN AREA

Apparently the inflorescences open early in the spring and early growth of the fruit is rapid, as the fruit was almost fully enlarged when I first observed it in early July. Apparently the comparatively low summer temperatures delay ripening. In 1952, Khadrawy, Hayany and Samany varieties ripened during September and early October; Halawy and Zahedi in late September and October; Barhee, Maktoom and Deglet Noor in October and November.

PROBLEMS IN CULTURE

The chief problems associated with date culture arise from atmospheric moisture and insect damage. The high humidity coupled with moderate temperatures and the high water table induce checking and even splitting of the fruit during August and September. A large oriental wasp (*Vespa orientalis*) attacks fruit in the Khalal stage as early as July and causes extensive damage unless the bunches

Table 1. Comparison of mean monthly temperatures in Israel and United States date districts.

	Israel*		U.S.	
	Jordan†	Elat	Mesa Ariz.	Indio Calif.
Jan.	57	59	49	54
Feb.	58	61	53	58
Mar.	60	67	58	65
Apr.	68	77	65	72
May	78	84	74	79
June	82	87	82	87
July	85	91	89	93
Aug.	87	92	86	92
Sept.	83	88	82	86
Oct.	78	80	70	75
Nov.	70	72	57	63
Dec.	61	63	50	55

*Israel records from: Climatological Normals; Series A: 1952; State of Israel Meteorological Service; Jerusalem.

†Jordan area: ave. of Tiberias and Beit Shean.

*The information in this paper is based upon observations made by the writer in Israel between June 18 and October 31, 1952.



Figure 1. Very heavy crop of fruit on Khadrawy palm growing at Kinneret near the south shore of Lake Tiberias. No bunches were removed and individual bunches were not thinned. September 1952.



Figure 2. Lifting water with a bucket from shallow dug well to irrigate recently planted offshoots at Ein Radian inland from Elat. Larger palms in background are seedlings planted in holes about four feet deep. August 1952.

are protected. The wasp is able to tear moderate weight cheese cloth, so only heavy jute sacks and bags made of wire screens offer effective protection. Because the humidity around the bunches is increased by the jute bags a large amount of spoilage occurred in 1952. Lack of foreign exchange has prevented the importation of wire screen material which effectively protects the fruit without inducing spoilage.

While spoilage losses have been high, it is evident that they can be markedly reduced by changes in garden culture and bunch management. At present, bunches are not thinned or aerated, and weeds are allowed to grow during the critical period for checking in the summer and fall. Palms are often irrigated where the water table is high, and even sprinklers are in use. By practicing clean cultivation between July and October, bunch thinning and aeration, and infrequent furrow or basin irrigation I feel that losses can be markedly reduced. Control of the oriental wasp outside the garden appears to be the most satisfactory method since it also causes wide spread damage to grapes, bees and carob trees and incapacitates workers.

Because of the low heat and high humidity the earlier, more moisture tolerant varieties such as Khadrawy and Halawi are now chiefly planted. In gardens located in the higher portions of the valley, where there is good air drainage and no carp ponds to raise the humidity, Zahedi and Deglet Noor are also included.

Parlatoria scale is present in all gardens but very heavy scale populations were observed only on the outer rows of one garden where the palms were covered with dust blown in from the adjacent road. Gaphiola leaf spot was present in most gardens. In many locations palms were observed which had small rectangular yellow flecks in the pinnae of the

fronds. The cause of this trouble is unknown. This condition was not present in all varieties in all gardens, and a detailed survey may reveal the factors associated with this condition.

The combined action of all the above factors shortens the life of the leaf. In most cases leaves died during the third and early part of the fourth year after emergence. Thus, most palms carried from 60 to 75 leaves. Since neither bunch thinning or bunch removal has been practiced, serious alternate bearing has developed. The 1952 season was the "on crop" year and many palms were carrying from 12 to 16 bunches. The extent of alternate bearing was reported to vary with varieties; very serious alternate bearing occurred on Barhee, whereas more regular heavy production has been obtained from Zahedi.

PICKING, CURING, PACKING AND MARKETING

Because the soft dates such as Khadrawy, Halawi, Barhee and Sayer ripen slowly and do not cure to a low moisture content much of the fruit is picked by hand. Oil or electrically heated curing rooms are used in almost all of the packing houses to complete maturation and dehydration of the fruit. The largest packing house at Kinneret has a mechanical shaker towel washer and a small grading belt similar to those used in the United States. The cured fruit is graded and packed either in small 200-gram cellophane bags, 2-kilo cardboard boxes or 10-kilo bulk field boxes which are later returned to the grower.

The Hayany fruit is handled according to the traditional methods of the Arabs. The entire bunch is cut when perhaps 5 per cent of the fruit has started to ripen. Dates are removed and immersed in a 1½ per cent solution of acetic acid for 1½ hours. This very wet fruit turns black after treatment and ferments quickly.

Even though it was packed loose in bulk containers and sent directly to the markets in Haifa and Tel Aviv, consumers reported a considerable amount of fruit had fermented when it was offered for sale. It is obvious that this unsatisfactory program should be stopped, and the fruit harvested as it ripens.

Dates are principally sold through the Tnuva cooperative marketing association. All are consumed in Israel. Since no dates are imported, production is low, demand is high, and there is a free market, dates sell at very high prices and are very profitable at present. However, because of the extra costs involved in thinning, picking and curing in Israel, it is doubtful if the Israeli grower in the Jordan area could compete with the Arab growers producing fruit under more favorable conditions in Iraq and North Africa.

THE ELAT AREA

The broad Wadi (valley) inland from Elat on the Red Sea has possibilities of becoming a valuable date producing area (see map). Here the temperature is high, and the humidity is low so the date fruit will cure on the palms. The water table is from three to six feet below the surface and the clay loam soils are highly saline. Less salinity occurs in certain areas, and below a depth of 24 inches particularly in the sandy loam soil types. Large seedling palms have been established by the Arabs by digging holes about three feet deep, planting seed and irrigating the young seedlings from shallow wells until the roots reach the water table. The growth of these palms has not been as good as in the Jordan area, but in as much as this land is too saline for other crops, and fruit can be produced cheaply, it offers promise as a potential date area. Importations of palms from the United States for planting in these areas are now being made.

A PANEL DISCUSSION OF DATE QUALITY AND ITS IMPORTANCE

PANEL MEMBERS:

J. W. Hadley (Valerie Jean Date Shop)
Hillman Yowell (California Date Growers' Association)
Truman J. Gridley (Date Grower)

William W. Cook (Date Grower)
Edward E. Smith (Valley Date Garden)
J. R. Furr, Moderator, (U. S. Date Garden)

J. R. Furr — Those of you who have been in the date industry many years are familiar with the deterioration that has taken place in the general quality of dates, both as they are delivered to the packing house and as they reach the consumer.

This situation has not come about through the indifference or carelessness of the growers and packers, but rather as a result of changes in both the physical and economic conditions of date production and handling. These have been changes which, for the most part, the growers and packers have not been able to control.

This panel discussion was placed on the program in the hope that it may contribute to a better understanding by the industry as a whole of the difficulties that must be faced by growers and handlers in an attempt to improve the general level of quality of the dates offered to the consumer.

It is also hoped that it may contribute to a better understanding of how, in the opinion of some of the most experienced growers and handlers, an improvement in over-all quality of the dates entering trade channels may benefit the whole industry and how these improvements may be brought about.

The several members of the panel have agreed to discuss different phases of this subject before we proceed to a general discussion from the floor. These discussions follow:

J. W. Hadley — (The Customer's Response to High Quality and the Direct Sales Effort.) Our operations differ from those of the date industry as a whole, in that all of the whole dates we sell are naturals and our customers are all consumers. Our customers show little objection to relatively high prices for high quality fruit after they understand the differences in dates. They show a great interest in our explanation of differences in quality and prices of the different kinds and grades of dates. They like the choice or fancy grades for gifts and good standards for home consumption. They want information about the different kinds and grades of dates and show remarkable loyalty to a dependable brand name.

From our direct contact with the consumer it seems that the following advice might help the industry: keep the industry in closer touch with the consumer's likes and dislikes; give the consumer good quality and charge for it reasonably; allocate some money

for a "plug" for "Quality California Dates;" forget about the other fellow's price and watch your quality and sell for a reasonable profit; produce more good natural dates; mark and advertise hydrated dates as "hydrated"; continue to explore for new products and uses to absorb the dry dates that can't be sold as whole Natural Dates.

Hillman Yowell—(Report on Quality Change in Deglet Noor Dates.) The California Date Growers' Association has kept a record of the grade-out of fruit of each crop received from 1920 to the present time. From these records we compiled a table showing the average percentage of each grade received in each decade up to the end of the 1952 crop year.

From these data it is apparent that the trend is away from natural dates and toward marketable dry or hydrated dates, accompanied by an increase in the substandard and culls. The year-to-year grade percentages show that back in the beginning there were years when the fruit wasn't all fancy. There were more dry Deglet Noor dates in some years than in others, but the percentage of marketable dry fruit was much smaller than it is today.

The standard natural grade appeared first in 1939 and has been increasing each season since that time. In the period 1920-1929 there is no substandard shown. Though reported in 1920, 1921 and 1922, the total was less than one per cent, so we did not show it here. This grade did not appear again until 1933. From 1933 up through the immediate post-war years, substandard went as high as 40 per cent of the crop. The two highest years were 1937, which was affected by the spring freeze, and 1947, during which the temperatures were above normal for the entire growing season.

The decline in the fancy and choice grades of natural dates and the increase in the marketable dry grade may be attributed to many factors. Some of these are: increase in pro-

duction labor costs, increase in height and age of the palms, and a general belief that drier grades of dates are more economical to produce, pack and market.

Truman Gridley — (The Relation Between Changing Cultural Practices and Decline in Quality) There is a direct relation between cultural practice and quality of fruit produced. Changing economic conditions in recent years have forced growers to change their production practices. The increase in labor necessary with the increase in height of the palms and the rise in practically all production costs, such as wages, machinery, irrigation-water and materials of all sorts, have forced the grower to make changes that would reduce his current expenses. There has been a reduction in the amount of fertilizer used, and in many gardens, in an effort to increase tonnage, there has been an overloading of the trees with lightly thinned bunches. This has resulted in an increase in dries, in shriveled, and in small fruit.

Many growers have abandoned the use of bunch covers and this has resulted in an increase in rain-damaged, split, and moldy fruit. In recent years picking has been less frequent and less careful. This has resulted in an increase in insect-infested culls, especially in hidden culls that cannot be sorted out.

While rising costs of production account for some of the change in quality of fruit produced, the demand by the packers for medium-sized, dry fruit when they began competing for the business of the chain stores is partly responsible for the decline in quality.

This demand for cheap fruit of mediocre quality encouraged the growers to produce a large tonnage of fruit that would just meet minimum quality requirements. This trend is shown by Yowell's figures for the percentages of the different grades produced during the last three years as compared to those of the previous ten years. In the period 1950-'52, 68

Table 1. The average percentage of different grades of fruit received in each decade during the period 1920-1952, inclusive.

	Fancy Per cent	Choice Natural Per cent	Standard Natural Per cent	Marketable Dry Per cent	Sub- standard Per cent	Culls Per cent
1920-'29	23.3	50.6		20.2	0.8	5.1
1930-'39	7.3	38.5	3.9	31.8	13.3	5.2
1940-'49	1.8	26.0	22.3	21.3	19.7	8.9
1950-'52	1.1	15.0	18.0	50.0	10.0	5.6

per cent of the fruit was standard naturals or marketable dry, while during the period 1940-'49 the fruit in these grades amounted to only 43.6 per cent of the total.

William W. Cook—(Methods for Improving Fruit Quality Without Serious Increase in Cost Per Pound.) From the grower's standpoint, "Crop Quality" means the average quality of his entire production. It does not mean the quality of the top ten or twenty or fifty per cent of his production. Anything that improves the character of any portion of his crop will increase the average crop quality. In the past, too much emphasis has been placed upon the top portion of the crop. We all know that a higher percentage of "Fancy" and "Choice" can be produced if the grower cuts his yield per bunch, increases certain cultural costs per acre and increases his harvesting cost per pound.

It is not suggested that growers should abandon all attempts to improve the top portion of the crop. It is suggested that growers can improve over-all crop quality by elimination of poor dates and that some things can be done to improve the character of the poorer portion of a particular crop without materially reducing per acre yield or increasing average cost per pound.

If the poor Standard, Substandard, and even culls can be reduced in percentage of total pounds produced without decreasing total yield, the grower will improve his quality. This type of crop improvement should permit a reduction in packing house cost and will foster an improvement in the final product offered to the consumer of dates and will result in higher per pound returns to the grower.

The way to do this can be boiled down to just four words: "Practice good farm management." Good farm management means doing all necessary operations promptly and efficiently and eliminating operations that are not necessary. Here are a few specific suggestions:

Irrigation

Irrigate when water is needed, not when the soil contains plenty of moisture. The proper amount of water per irrigation and the time interval between irrigations depend upon the weather and soil type, and no rule of thumb for frequency of irrigation and amount of water is applicable. Above all, don't permit irrigation to be delayed during spring and early summer. More poor fruit results from excessive soil dryness during this period (February-July) than from any other cause.

Half an acre foot every two weeks appears about right for average soil during summer, with longer intervals

and some reduction in volume of water per irrigation during cooler or more humid weather. This is a generality and does not apply to all soils.

Costs can be reduced if water is used efficiently. Even distribution of water to all parts of the field will improve quality and save water. Good irrigating lay-out can reduce labor requirement.

Fruit Management

There is a proper time and a proper way to thin and support bunches, to dust fruit, to apply date covers, and to pick. It costs no more to do these operations at the right time and it should cost little more to do them in the right way.

Fertilizer

Here is a field in which data are not very good. It has been shown that if no fertilizer is applied there will be an eventual reduction in yield and quality. All that is suggested here is that each grower get the best information available as to the requirements of his soil and then adopt a regular program of fertilizer application and stick to that program, regardless of date prices, until such time as a better program of fertilization is developed. Money is wasted on fertilizer that is not needed. It is believed that a sound fertilization program, consistently followed, will result in higher yield and better quality without increasing cost per pound.

E. E. Smith—(How Fruit of Poor Quality Affects the Packing House.) For the past several years fruit quality has been in a downward spiral. This condition has been brought about by several factors: (1) small price differential between fancy, choice and standard grades; (2) small price differential between natural and dry dates; (3) low returns with resultant relaxation of good growing practices.

It would seem that there is general agreement that the industry must raise its grade standards. Generally, the packers are in accord with this. It must be borne in mind that the packer is limited in what he can do with low quality dates.

Every effort is being made to grade and process the poor types of fruit in such a manner as to produce the largest amount of fruit that will give customer satisfaction and repeat orders. But, as the old saying goes, "You can't make a silk purse from a sow's ear." The first step in better quality must come from the grower. We have found no satisfactory way to process immature, shriveled dates, dates of rubbery texture, or those with such defects as spider damage, pinch nose, and scars. Handling of large tonnages of marginal dates will, obviously, increase the over-all cost of grading and packing. Poor fruit takes up as much room as good fruit

in fumigators, curing rooms and on washers and grading belts. It increases the amount of fruit that must be handled, and thus the cost of the fruit in each package.

Let us not lose sight of the fact that good quality does not necessarily mean that the dates must be naturals. Good waxy-tips and good meaty dry fruits, free from blemishes, can be handled in such a manner as to produce a favorable market reaction. In fact, there are large markets in which the preference is for the properly processed dates of proper moisture content.

J. R. Furr—In his discussion, Ed Smith said there is only a small differential between the low grade and high grade fruit in returns to growers. This was, I think, a highly significant remark. This small difference between the returns received for high and low grades is probably one of the principal reasons why the grades have drifted down during the last few years. And Mr. Gridley said that, without this differential in grade, the grower is encouraged to increase the volume of production rather than to improve the quality.

I should like to know if anyone on the panel would like to answer the question as to why we do not have a wider differential in returns between the high and low grades?

This question was addressed to Hillman Yowell.

Hillman Yowell—The present situation dates back to the war period when prices were very high for all dates and growers began to concentrate on quantity rather than quality. Since that time there has not been enough good quality fruit to justify the expense of careful and thorough grading which would make large differences between grades.

Truman Gridley asked Mr. Swingle whether, in his opinion, there would be a greater price differential between grades if the growers raised better fruit.

Leonhardt Swingle — To increase the percentage of top grades would not help much unless the general quality of the crop is improved. There is not an unlimited sale for top quality fruit at high prices, and the grower would profit most from raising the quality of the crop as a whole. It is especially important to reduce mite damage, premature shrivel and other defects, as well as to increase size. These are grower problems. Even during recent years our packing house has paid a price differential of 2 or 3 cents between grades.

Dean Halsey asked why growers are not doing the things they should do to produce better quality fruit.

T. R. Brown commented that he could not answer the question,

but he considered the discussion itself was valuable as it brought out in the open a situation that many had been complaining about for years. He suggested that the high prices which prevailed for all grades of fruit during the war, in addition to encouraging the production of quantity rather than quality, favored the retention of marginal date gardens which should have gone out of production completely. He also stated that the quality of the fruit from his old palms was not as good as that from his young palms and the increasing age of the palms throughout the Valley might be one factor in the decline of quality. He added that marketing surveys have shown that when good dates are marketed the volume of sales goes up.

D. H. Mitchell commented that unless quality is good enough to warrant a repeat sale, no progress can be made, and that there is too much borderline fruit being marketed. He thought that many palms are being overloaded, but that failure to carry out consistent cultural practices, especially adequate irrigation, proper fertilization and frequent picking, was often responsible for failure to get a high percentage of top quality fruit. Low rates may increase efforts to cut costs. It is a question of whether the chicken or the egg came first; whether low prices are responsible for low quality or vice versa.

J. R. Furr—Every grower will admit that we can't produce an entire crop of high quality dates in some seasons, such as the last one in which weather was unfavorable for high quality Deglet Noors. What do you think about the possibility of reducing the amount of low grade fruit that goes to the consumer? Is it feasible to eliminate any appreciable part of the low grade fruit from the regular channels of trade?

Leonhardt Swingle—It is the problem of the grower to raise the average quality of his fruit. If low grade fruit is delivered to the packer, he has no alternative but to attempt to dispose of it. As much perhaps as the lowest 15 or 20 per cent of the crop might be diverted into substandard channels, but certainly not 50 per cent.

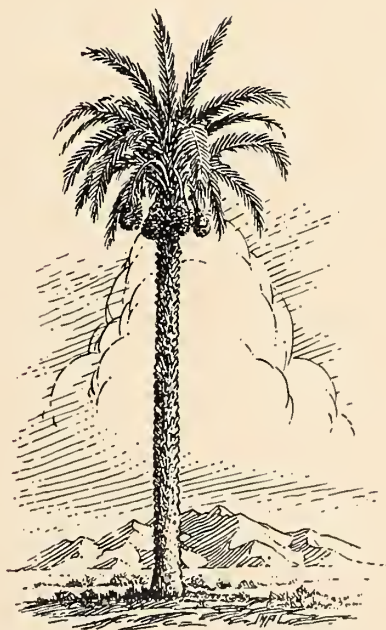
Ronald Johnson suggested that written contracts guaranteeing the grower a certain price for all marketable fruit had tended to encourage the production of maximum quantity to meet minimum standards.

Truman Gridley suggested that Mr. Richardson might have some remarks to make, based on his recent experience in marketing other fruits.

Hilton Richardson said that the problems in marketing dates are not greatly different from those encountered with grapes, apricots and citrus. In marketing these products, growers

accepted for many years what buyers in the East told them the consumer wants. It was found, however, that no one had ever made any tests to find out. How important it is to find out what the consumer wants is illustrated by an experience of Golden State in developing a chocolate milk to be put on the market. They decided which of several samples they wanted to put out; then someone suggested that they had better find out which the consumer preferred. The results of actual tests showed that the consumer's preference was the exact opposite of what the experts thought.

J. R. Furr—It seems to me that this problem is like that of the irresistible force striking the immovable object. The grower thinks he cannot eliminate low grade fruit, and the packer thinks that he has to sell whatever the grower produces. It is apparent, however, that in many cases, dates of poor quality are driving dates of high quality out of the market. How can we change this situation? It's obvious that no one has suggested a solution that appears to be satisfactory for both grower and packer. It is a difficult problem and not easily solved; but perhaps this discussion has contributed in some degree to an understanding that in time will help in the solution of the problem.



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